

Large- and medium-bodied terrestrial mammals of the Upper Berbice region of Guyana

Meshach A. Pierre^{1,2}, Leroy Ignacio³, Evi A. D. Paemelaere^{1,4}

1 Panthera, 8 W 40th St 18th floor, New York, NY 10018, USA. **2** Winston Cobb Fellow, Panthera, 8 W 40th St 18th floor, New York, NY 10018, USA. **3** South Rupununi Conservation Society, Shulinab, Upper Takutu-Upper Essequibo, Guyana. **4** People & Wildlife Solutions, Manari, Region 9, Guyana.

Corresponding author: Meshach A. Pierre, meshachpierre@gmail.com

Abstract

Large mammals are key contributors to forest ecosystems globally, but Neotropical mammal populations are understudied. We employed remotely triggered camera traps and track surveys to assess the mammal community in the newly accessible upper Berbice region of Guyana. In a cumulative 2,821 trap nights between two camps and 14 km of track surveys we recorded 18 species of mammals. Camera trap records showed that Red-Rumped Agouti (*Dasyprocta leporina* (Linnaeus, 1758)) featured the highest relative abundance at both camps, while Tayra (*Eira barbara* (Linnaeus, 1758)), Amazonian Brown Brocket Deer (*Mazama nemorivaga* (F. Cuvier, 1817)), Giant Anteater (*Myrmecophaga tridactyla* (Linnaeus, 1758)) and Giant Armadillo (*Priodontes maximus* (Kerr, 1792)) the lowest. We also report naïve occupancy estimates. Detections of threatened and disturbance sensitive species indicate that the study site has a high biodiversity value. We provide recommendations for further study in this recently disturbed ecosystem and other understudied regions of Guyana.

Keywords

Biodiversity, camera traps, Guiana Shield, non-volant, rapid assessment, relative abundance.

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Introduction

Large mammals are key contributors to healthy forest ecosystems. Frugivores such as monkeys and tapirs serve as seed dispersers, large predators exert a top-down regulation on ecosystems, while habitat architects such as peccaries and giant armadillos alter ecosystem functions through their wallows and disturbance (Julliot 1997; Andresen 1999; Fragoso et al. 2003; Link and Di Fiore 2006; Altrichter et al. 2012; O’Farrill et al. 2013; Desbiez

and Kluyber 2013). Furthermore, large predators require healthy populations of prey, and as a result their populations reflect the state of the ecosystems they inhabit (Aranda and Sánchez-Cordero 1996; Carbone and Gittleman 2002; Lopez González and Miller 2002). In spite of technological advances, such as the development of digital camera traps, to study these mostly elusive species (Rowcliffe and Carbone 2008; Tobler et al. 2008),

some areas have remained understudied, limiting information to support management decisions and ensure functional ecosystems in the face of development.

The Guiana Shield eco-region (2.28 million km²) contains one of the last remaining frontier forests in the world (Bryant et al. 1997), hosting over 1.61 million km² of tropical forest (Hammond 2005). This region of northern South America spans six countries and comprises mostly intact forest, savanna and montane ecosystems with high rates of species endemism (Hammond 2005; Naka 2011), but there has been little research on mammals there (Lim 2016). The countries of the Guiana shield each maintain among the highest percentages of forest cover worldwide (Hammond 2005). Guyana, Suriname and French Guiana have maintained 84%, 95.4%, and 98.6% standing forest, respectively (FAO 2015). Part of this has been due to the concentration of the human populations along the Caribbean coasts, and limited paved roads, causing poor accessibility of their interior landscapes (Richardson and Funk 1999).

Nevertheless, the interior is also host to a wealth of timber and mineral resources, and natural resource extraction has been one of the main economic activities for Guyana (Guyana Lands and Surveys Commission 2013). Guyana's natural resource extraction-based economy has spurred development of a dense network of dirt roads, providing access mostly to off-road vehicles, but facilitating new settlements around concessions and providing access to hunters, with implications for wildlife.

Given the new offshore oil industry in the country (Ali and Schena 2018), the increase in financial resources is likely to lead to further expansion of inland infrastructure, increasing the accessibility of previously remote habitats.

Guyana's wildlife has remained largely understudied, especially with regard to large mammals (Lim 2016). Although a growing body of scientific work exists, few studies have focused on sites that have not been previously disturbed (Hallett et al. 2019; Paemelaere et al. unpublished data). This study evaluated medium-large mammal diversity, abundance and species richness in a region of the Upper Berbice river area, which was relatively inaccessible until 2013–2014, when exploration and extraction activities of logging concessions situated in this region began.

Methods

Our surveys were conducted in the dry seasons from February–April and August–November. Surveys were conducted along a section of the Upper Berbice River in eastern Guyana from the 18 Sep. to the 13 Nov. 2014, with additional camera trapping conducted from the 21 Feb. to the 20 Apr. 2016. The study area consisted of previously undisturbed mixed lowland forest (Fig. 1), with no recent history of settlements, roads, or other human activity. Between 2013 and 2014, however, road development expanded southward, parallel to the Berbice River,

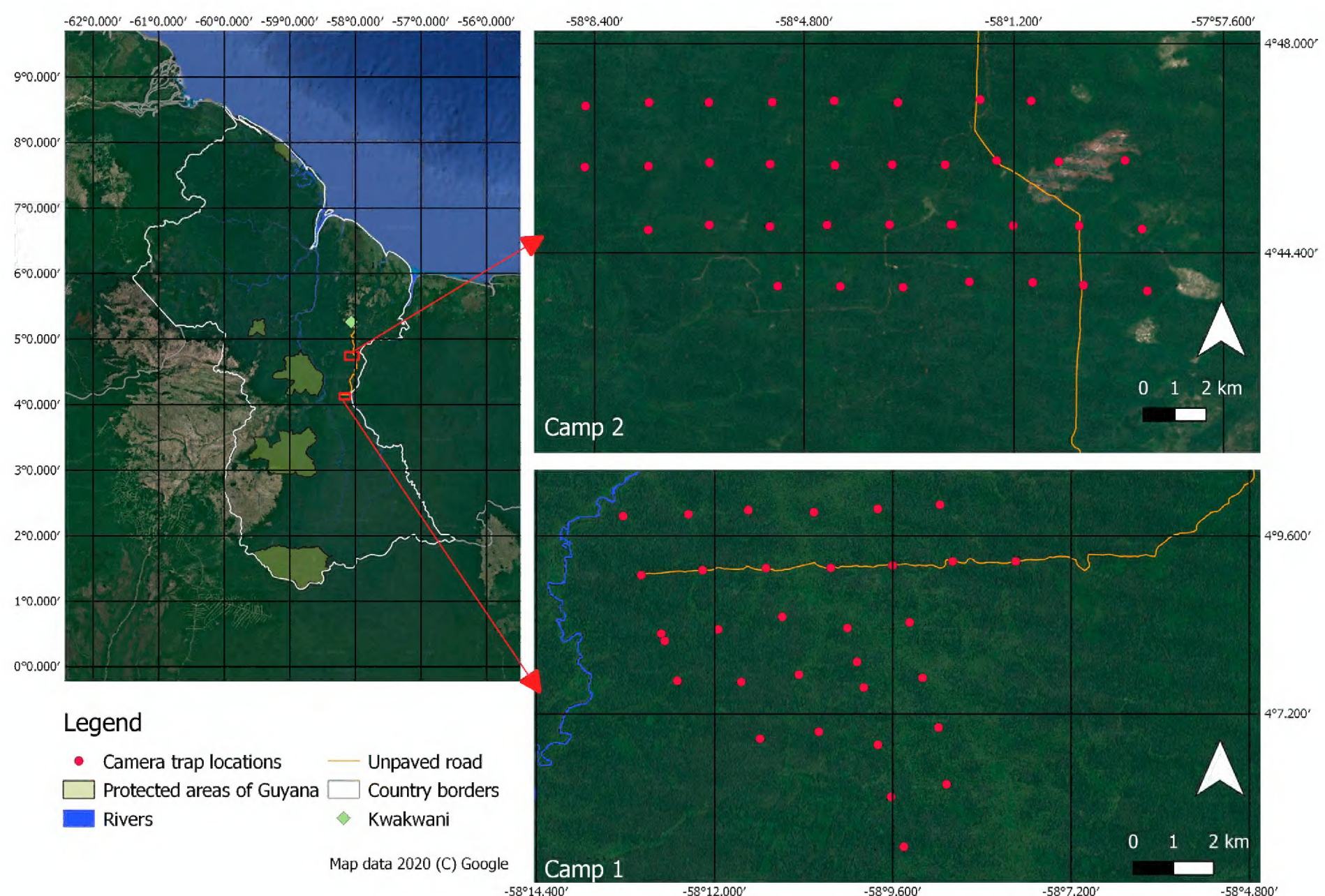


Figure 1. Maps showing Guyana, study sites and camera trap grids.

from the logging town of Kwakwani to provide access to potential logging operations. This unpaved road consisted of a mix of laterite and sand, varying with the soil types it passed through. Two sites south of Kwakwani were selected for survey. The Upper Berbice River Camp (04°09.23'N, 058°10.64'W; hereafter Camp 1) was situated along an access road constructed in 2014 to access the Berbice River from the end of the main logging road, approximately 123 km from Kwakwani. The Upper Berbice White Sands Camp (04°45.32'N, 058°00.43'W; hereafter Camp 2) was situated within a kilometer-long stretch of recently burnt forest along the main logging road, around 56 km from Kwakwani.

Habitat. The area surrounding Camp 1 was composed of forest with laterite soil dominated by *Mora excelsa* (Benth.) and *Astrocaryum* sp. palms. The habitat in Camp 2 was situated in forest dominated by Dakama (*Dimorphandra conjugata* (Spligt.)), Soft Wallaba (*Eperua falcata* (Aubl.)), and Turu Palms (*Oenocarpus bacaba* (Mart.)), with white sandy soil covered in thick leaf litter and roots.

Camera trapping. At Camp 1, we set 32 cameras (Cuddeback® Capture) in a rectangular grid with cameras about 1.5 km apart (Fig. 1). Specific site selection was not based on presence of human made trails, but at every camera site we identified the most likely location for wildlife to be detected. At Camp 2, we set 35 cameras (Panthera® IV, Cuddeback® Attack, and Bushnell® Trophy Cam #119436) about 2 km apart. Cameras were set at 60 cm high and 1.5–3.0 m from the site where wildlife was expected to pass, programmed to take one photo per trigger, with a 30 second delay to re-activation, and were active during both day and night. At both sites we achieved a minimum of 1,000 trap nights to permit detection of all but the rarest species (Tobler et al. 2008).

Live sightings and tracks. Live sightings, vocalizations, and tracks were recorded opportunistically at Camp 1, while at Camp 2, we survey systematically along three established transects. Each transect was 2–3 km long, one (A) followed a laterite road with sandy edges through burnt forest into the edge of the live forest, a second (B) along a white sand road that branched off from the main logging road through the burnt forest, and a third (C) followed a white sand logging track through Dakama forest. We walked each transect twice covering 14 km total. Repeat surveys occurred two to three days after the first survey.

Data analysis. We analyzed the data using Program R (R Core Team 2020). We calculated the relative abundance index (RAI) of mammals detected by camera trap, using the number of observations/(100*trap nights) (Carbone et al. 2001). Images of the species of interest that occurred at the same trap site within a period of 30 min were excluded to ensure that photo occasions were independent (Silver et al. 2004). To account for microhabitat variation between camera trap stations, we bootstrapped

the relative abundance of each species captured at each camera trap, using 1,000 repetitions. Bootstrapped RAI is reported alongside the standard RAIs for comparison. We calculated naïve occupancy (Ψ) by first standardizing camera trap effort at 40 trap nights for the camera traps, then calculating the number of sites observed divided by total number of sites for each species (Rovero and Zimmermann 2016). Species richness and diversity (inverse Simpson and log α diversity values) for each site were calculated with the recommended Jackknife 2 estimator (Tobler et al. 2008) using R packages vegan (Oksanen et al. 2019) and BiodiversityR (Kindt and Coe 2005).

Results

At Camp 1, we surveyed 1,325 trap nights which resulted in 236 independent photographs, including 207 photos of 14 mammal species, 25 photos of two bird species, and four photos from which the species could not be identified. At Camp 2, we surveyed 1,496 trap nights and recorded 539 independent photographs, including 384 photos of 18 mammal species, 118 photos of 6 bird species, and four photos which could not be identified. Ad hoc track surveys from Camp 1 detected in six mammal species, while at Camp 2 track transects detected 10 (Table 1).

Species accumulation curves for the camera trap studies at Camp 1 and 2 reached the asymptote, indicating sufficient sampling effort at each site. Jackknife 2 estimates resulted in a mean of 15.01 species at Camp 1, and 16.10 species at Camp 2 (Fig. 2). At Camp 1, Red-Rumped Agouti (*Dasyprocta leporina* (Linnaeus, 1758)) showed the highest RAI, while Tayra (*Eira barbara* (Linnaeus, 1758)) and Amazonian Brown Brocket Deer (*Mazama nemorivaga* (F. Cuvier, 1817)) the lowest (Fig. 3). Red Brocket Deer (*Mazama americana* (Erxleben, 1777)) and Collared Peccary (*Pecari tajacu* (Linnaeus, 1758)) showed the highest naïve occupancy (Ψ), while Red Acouchi (*Myoprocta acouchy* (Erxleben, 1777)), Jaguarundi (*Herpailurus yagouaroundi* (É. Geoffroy Saint-Hilaire, 1803)), *E. barbara*, and *M. nemorivaga* showed the lowest (Table 1). The inverted Simpson diversity index for Camp 1 was 7.10, with a log α mean of 3.08. At Camp 2, *D. leporina* also had the highest RAI, while Giant Anteater (*Myrmecophaga tridactyla* (Linnaeus, 1758)) and Giant Armadillo (*Priodontes maximus* (Kerr, 1792)) showed the lowest RAI (Fig. 3). *Dasyprocta leporina* showed the highest naïve occupancy (Ψ), while *M. tridactyla* showed the lowest (Table 1).

The inverted Simpson index for Camp 2 was 9.33, with a log α mean of 3.93. Jaguarundi (*Herpailurus yagouaroundi* (É. Geoffroy Saint-Hilaire, 1803)) was only recorded at Camp 1, while Crab-Eating Fox (*Cerdocyon thous* (Linnaeus, 1766)), Margay (*Leopardus wiedii* (Schinz, 1821)), South American Coati (*Nasua nasua* (Linnaeus, 1766)), and White-lipped Peccary (*Tayassu pecari* (Link, 1795)) were only recorded at Camp 2.

Table 1. Mammal species encountered, relative abundance indices (RAIs: 100(number of encounters/trap nights)), and naïve occupancy (Ψ) for species encountered via camera traps.

Scientific name	Common name	Camp 1			Camp 2			IUCN status
		RAI	Bootstrapped RAI	Naïve occupancy (Ψ)	RAI	Bootstrapped RAI	Naïve occupancy (Ψ)	
PILOSA								
<i>Myrmecophaga tridactyla</i> (Linnaeus, 1758)	Giant Anteater	0.21	0.22 (0–0.5)	0.1	0.14	0.13 (0–0.33)	0.03	Vulnerable
CINGULATA								
<i>Dasypus</i> sp.	Armadillo	0.36	0.34 (0.07–0.73)	0.14	2.91	3.83 (1.49–6.57)	0.38	Vulnerable
<i>Priodontes maximus</i> (Kerr, 1792)	Giant armadillo		Burrow		0.14	0.13 (0–0.34)	0.07	
PRIMATES								
<i>Alouatta macconnelli</i> (Linnaeus, 1766)	Guianan Red Howler Monkey		Vocalizations					Least Concern
<i>Ateles paniscus</i> (Linnaeus, 1758)	Guiana Spider Monkey		Vocalizations					Vulnerable
<i>Sapajus apella</i> (Linnaeus, 1758)	Guianan Brown Capuchin		Vocalizations, live					Least Concern
<i>Pithecia pithecia</i> (Linnaeus, 1766)	White-faced Saki		Vocalizations, live					Least Concern
RODENTIA								
<i>Cuniculus paca</i> (Linnaeus, 1766)	Lowland Paca	1.77	1.73 (0.71–3.15)	0.38	2.2	1.96 (0.19–4.44)	0.14	Least Concern
<i>Dasyprocta leporina</i> (Linnaeus, 1758)	Red-Rumped Agouti	3.9	4.05 (1.92–6.62)	0.34	5.75	5.44 (3.23–7.96)	0.55	Least Concern
<i>Myoprocta acouchy</i> (Erxleben, 1777)	Red Acouchi	0.14	0.16 (0–0.43)	0.03	0.64	1.46 (0–4.43)		Least Concern
CARNIVORA								
<i>Herpailurus yagouaroundi</i> (É. Geoffroy Saint-Hilaire, 1803)	Jaguarundi	0.14	0.13 (0–0.33)	0.03				Least Concern
<i>Leopardus pardalis</i> (Linnaeus, 1758)	Ocelot	1.63	1.67 (0.55–3.26)	0.4	1.77	1.68 (0–4.66)	0.1	Least Concern
<i>Leopardus wiedii</i> (Schinz, 1821)	Margay				0.21	0.20 (0–0.50)	0.07	Near Threatened
<i>Panthera onca</i> (Linnaeus, 1758)	Jaguar	1.28	1.49 (0.63–2.63)	0.28	0.28	0.27 (0–0.73)	0.07	Near Threatened
<i>Puma concolor</i> (Linnaeus, 1771)	Puma	1.06	1.28 (0.36–2.39)	0.14	0.5	0.47 (0.06–1.01)	0.14	Least Concern
<i>Eira barbara</i> (Linnaeus, 1758)	Tayra	0.07	0.08 (0–0.22)	0.03	0.5	0.46 (0.19–0.78)	0.27	Least Concern
<i>Cerdocyon thous</i> (Linnaeus, 1766)	Crab-eating fox				1.56	1.39 (0–3.99)	0.1	Least Concern
<i>Nasua nasua</i> (Linnaeus, 1766)	South American coati				0.28	0.27 (0.06–0.66)		Least Concern
PERISSODACTYLA								
<i>Tapirus terrestris</i> (Linnaeus, 1758)	Tapir	0.5	0.51 (0.13–1.07)	0.1	3.4	3.67 (1.12–7.34)	0.31	Vulnerable
CETARTIODACTYLA								
<i>Mazama americana</i> (Erxleben, 1777)	Red brocket deer	2.13	2.38 (1.32–3.75)	0.52	2.48	2.45 (0.94–4.59)	0.38	Data Deficient
<i>Mazama nemorivaga</i> (F. Cuvier, 1817)	Grey brocket deer	0.07	0.07 (0–0.22)	0.03	2.41	2.95 (1.46–4.83)	0.41	Least Concern
<i>Tayassu pecari</i> (Link, 1795)	White-lipped peccary				1.49	1.69 (0.32–3.61)	0.07	Vulnerable
<i>Pecari tajacu</i> (Linnaeus, 1758)	Collared Peccary	3.83	4.00 (2.21–6.11)	0.52	3.62	3.56 (1.42–5.97)	0.38	Least Concern

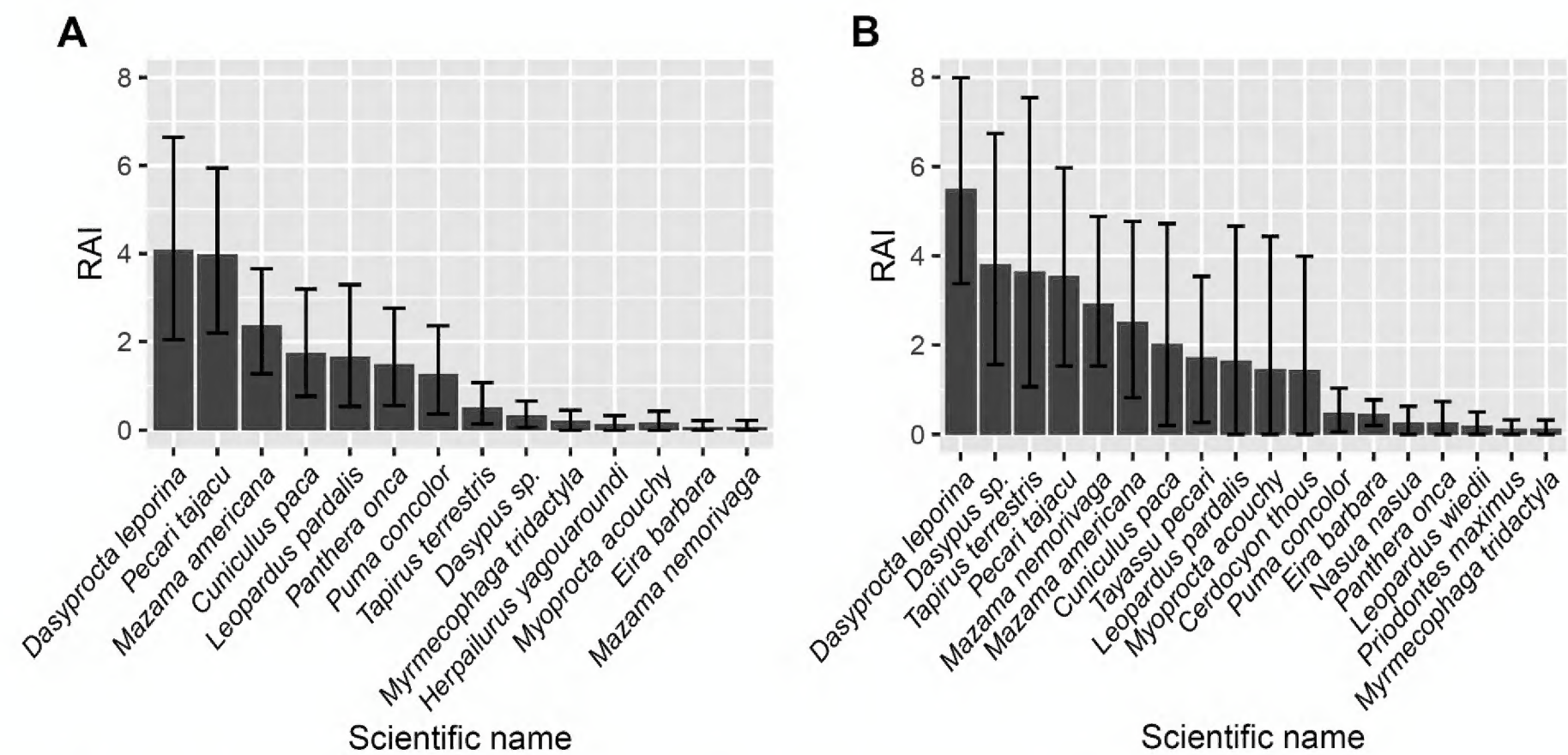


Figure 3. Relative abundance indices (RAIs) for species captured using camera traps at Camp 1 (A), and Camp 2 (B).

Annotated List of Records

Order Pilosa

Myrmecophaga tridactyla (Linnaeus, 1758)

Figure 4A

New record. GUYANA • East Berbice-Corentyne Region (6); 04°08.35'N, 058°10.21'W; 22 Sep. 2014; camera trap photo.

Identification. Identified by its long snout, gray, black and white striped body, and large bushy tail (Emmons and Feer 1997).

Order Cingulata

Priodontes maximus (Kerr, 1792)

Figure 4B

New record. GUYANA • East Berbice-Corentyne Region (6); 04°44.85'N, 058°05.38'W; 27 Feb. 2016; camera trap photo.

Identification. Identified by its large size relative to other armadillo species, and light band at base of carapace (Emmons and Feer 1997).

Order Primates

Alouatta macconnelli (Linnaeus, 1766)

New record. GUYANA • East Berbice-Corentyne Region (6); 04°09.23'N, 058°10.64'W; 18–25 Sep. 2014; opportunistic observation.

Ateles paniscus (Linnaeus, 1758)

New record. GUYANA • East Berbice-Corentyne Region (6); 04°09.23'N, 058°10.64'W; 18–25 Sep. 2014; opportunistic observation.

Sapajus apella (Linnaeus, 1758)

New record. GUYANA • East Berbice-Corentyne Region (6); 04°09.23'N, 058°10.64'W; 18–25 Sep. 2014; opportunistic observation.

Pithecia pithecia (Linnaeus, 1766)

New record. GUYANA • East Berbice-Corentyne Region (6); 04°09.23'N, 058°10.64'W; 18–25 Sep. 2014; opportunistic observation.

Order Rodentia

Cuniculus paca (Linnaeus, 1766)

Figure 4D

New record. GUYANA • East Berbice-Corentyne Region (6); 04°08.18'N, 058°12.67'W; 22 Sep. 2014; camera trap photo.

Dasyprocta leporina (Linnaeus, 1758)

Figure 4E

New record. GUYANA • East Berbice-Corentyne Region (6); 04°07.55'N, 058°09.99'W; 21 Sep. 2014; camera trap photo.

Identification. Identified by its bright red rump, lack of a tail, and overall larger size relative to Red-Rumped Acouchi (Emmons and Feer 1997).

Myoprocta acouchy (Erxleben, 1777)

Figure 4F

New record. GUYANA • East Berbice-Corentyne Region (6); 04°06.86'N, 058°11.38'W; 21 Oct. 2014; camera trap photo.

Identification. Identified by its dark rump, the presence of a short tail, and its overall smaller size relative to Red-Rumped Agouti (Emmons and Feer 1997).

Order Carnivora

Herpailurus yagouaroundi (É. Geoffroy Saint-Hilaire, 1803)

Figure 5C

New record. GUYANA • East Berbice-Corentyne Region (6); 04°07.01'N, 058°08.98'W; 12 Oct. 2014; camera trap photo.

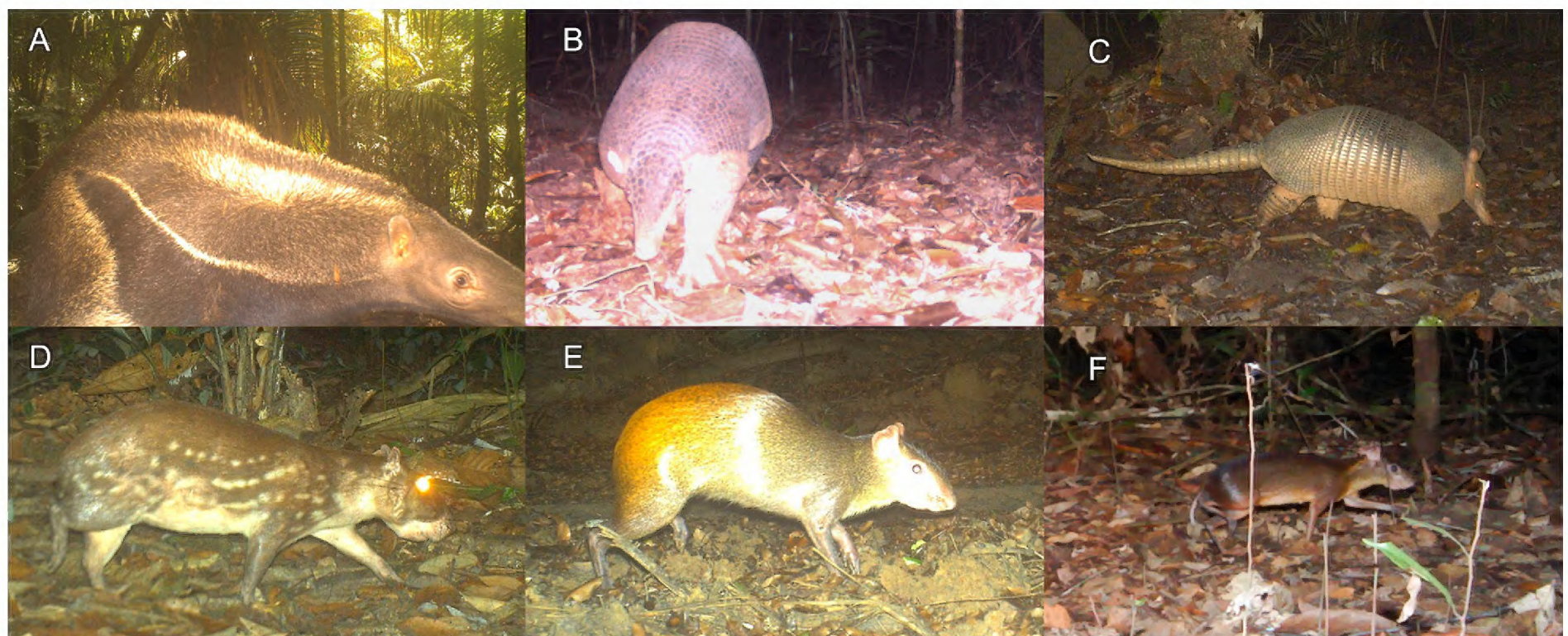


Figure 4. Mammal species recorded using camera traps: (A) *Myrmecophaga tridactyla*, (B) *Priodontes maximus*, (C) *Dasyprocta* sp., (D) *Cuniculus paca*, (E) *Dasyprocta leporina*, and (F) *Myoprocta acouchy*.

Identification. Identified by its long, stunted body. Smaller than Puma (*Puma concolor*) but larger than other small cats found in the same area. Only the dark morph was observed (Emmons and Feer 1997).

***Leopardus pardalis* (Linnaeus, 1758)**

Figure 5D

New record. GUYANA • East Berbice-Corentyne Region (6); 04°06.78'N, 058°09.80'W; 20 Sep. 2014; camera trap photo.

***Leopardus wiedii* (Schinz, 1821)**

Figure 5E

New record. GUYANA • East Berbice-Corentyne Region (6); 04°44.87', 058° 00.07'W; 25 Feb. 2016; camera trap photo.

Identification. Identified by the tail length, which is longer than the hind leg (Emmons and Feer 1997).

***Panthera onca* (Linnaeus, 1758)**

Figure 5G

New record. GUYANA • East Berbice-Corentyne Region (6); 04°09.20'N, 058°09.60'W; 21 Sep. 2014; camera trap photo.

Identification. Largest spotted cat in the Neotropics, with yellow fur spotted with black rosettes (Emmons and Feer 1997).

***Puma concolor* (Linnaeus, 1771)**

Figure 5H

New record. GUYANA • East Berbice-Corentyne Re-

gion (6); 04°09.13'N, 058°12.16'W; 21 Sep. 2014; camera trap photo.

***Eira barbara* (Linnaeus, 1758)**

Figure 5B

New record. GUYANA • East Berbice-Corentyne Region (6); 04°10.01'N, 058°08.96'W; 24 Sep. 2014; camera trap photo.

***Cerdocyon thous* (Linnaeus, 1766)**

Figure 5A

New record. GUYANA • East Berbice-Corentyne Region (6); 04°44.87'N, 058°00.07'W; 25 Feb. 2014; camera trap photo.

***Nasua nasua* (Linnaeus, 1766)**

Figure 5F

New record. GUYANA • East Berbice-Corentyne Region (6); 04°43.74'N, 057°58.90'W; 14 Apr. 2016; camera trap photo.

Order Perissodactyla

***Tapirus terrestris* (Linnaeus, 1758)**

Figure 5I

New record. GUYANA • East Berbice-Corentyne Region (6); 04°09.91'N, 058°10.66'W; 01 Oct. 2014; camera trap photo.

Order Cetartiodactyla

***Mazama americana* (Erxleben, 1777)**

Figure 6A



Figure 5. Mammal species recorded using camera traps: (A) *Cerdocyon thous*, (B) *Eira barbara*, (C) *Herpailurus yagouaroundi*, (D) *Leopardus pardalis*, (E) *Leopardus wiedii*, (F) *Nasua nasua*, (G) *Panthera onca*, (H) *Puma concolor*, and (I) *Tapirus terrestris*.



Figure 6. Mammal species recorded using camera traps: (A) *Mazama americana*, (B) *Mazama nemorivaga*, (C) *Pecari tajacu*, and (D) *Tayassu pecari*.

New Record. GUYANA • East Berbice-Corentyne Region (6); 04°09.91'N, 058°10.66'W; 25 Sep. 2014; camera trap photo.

Identification. Identified by its red coat and larger body size relative to red brocket deer (Emmons and Feer 1997; Varela et al. 2010).

***Mazama nemorivaga* (F. Cuvier, 1817)**

Figure 6B

New record. GUYANA • East Berbice-Corentyne Region (6); 04°09.86'N, 058°13.23'W; 28 Oct. 2014; camera trap photo.

Identification. Identified by its grayish-brown coat, and smaller body size than red brocket deer (Rossi et al. 2010).

***Pecari tajacu* (Linnaeus, 1758)**

Figure 6C

New record. GUYANA • East Berbice-Corentyne Region (6); 04°07.89'N, 058°10.08'W; 18 Sep. 2014; camera trap photo.

Identification. Identified by the ring of yellow hair around the neck (“collar”) and smaller body size relative to White-Lipped Peccary (Emmons and Feer 1997).

***Tayassu pecari* (Link, 1795)**

Figure 6D

New record. GUYANA • East Berbice-Corentyne Region (6); 04°43.82'N, 058°04.18'W; 14 Mar. 2016; camera trap photo.

Identification. Identified by the white hair around its

jaw and large size relative to collared peccary (Emmons and Feer 1997).

Discussion

This study was part of a baseline assessment of the medium and large mammal populations at two sites in the upper Berbice region of Guyana. This formerly intact lowland forest was recently exposed to human activity by the opening of a road to access timber resources. In order to assess the impact of these activities, we used camera traps, live sightings and tracks for a rapid assessment of terrestrial medium-to-large mammal richness and diversity. Overall, we detected 22 mammal species (18 semi-terrestrial mammal species and four primate species), including threatened species and top predators, albeit at comparatively low relative abundance. Although part of a continuous forest, the sites showed slight differences in species detected and relative abundance of shared species.

At both camps, we detected threatened species, such as giant anteater, and Black Spider Monkeys, *Ateles paniscus* (Linnaeus, 1758), which prefer intact forests (Quiroga et al. 2016), therefore suggesting that the level of disturbance in the area was still low. This is further supported by the presence of *M. acouchy*. Although not threatened, this species typically avoids disturbance (Dubost 1988). Of note is the detection of *T. pecari*, a preferred species for hunters in Guyana (Hallett et al. 2019), but one which has faced range-wide as well as local declines within Guyana (Altrichter et al. 2012; Fragoso

et al. 2016). Further indication of low disturbance was the observation of large predators, both with camera traps and through live sightings. This not only indicates sufficient prey availability to support their presence, particularly in the absence of domestic livestock, but it also suggests that human interference has been limited to has not yet instilled fear in typically elusive animals to be visible to people (Kilgo et al. 1998; Carter et al. 2012).

Nevertheless, relative abundance values of most species were comparatively low compared to other study sites in Guyana with varying degrees of disturbance, including lowland forest sites featuring logging, mining and hunting, and savannah (Pickles et al. 2011; Hallett et al. 2019; Paemelaere et al. unpublished data). This could be explained by habitat variation or recent human disturbance or both. Indeed, we encountered few surface water bodies within the camera trap grid, and creek beds were mostly dry. Therefore, distribution of mammals in the area may have been skewed. This may be reflected in the occupancy results, where species with high relative abundances occupied a lower portion of camera traps (Table 1). Additionally, with the recent opening of the road and introduction of hunting, wildlife may have, perhaps temporarily, redistributed away from this new disturbance (Gaynor et al. 2018). On the other hand, species diversity was equivalent or higher than the above mentioned studies that were conducted in forest habitats (Paemelaere et al. unpublished data; Pierre et al. unpublished data), and as such the area is of high biodiversity value.

The camera trap survey effort was sufficient for the capture of species that are relatively common (Tobler et al. 2008), and the plateau of the accumulation curve supported this notion (Fig. 2). While differences between relative abundance values between sites could be due to habitat variation, differences in the model of the camera traps employed could also have played a role, as they did differ in motion sensitivity, trigger speed, and detection range (Findlay et al. 2020). Track surveys were limited by a lack of clear trails and the presence of vehicular traffic. Distance covered was also limited due to time constraints in this rapid assessment. Camera traps are thus more efficient in detecting mammalian diversity than tracking (Silveira et al. 2003; Fragoso et al. 2016), especially during these exploratory studies. Cameras, on the other hand, are limited to terrestrial species. Therefore, transects for tracks and live sightings offer an ideal complement in rapid assessments to detect other species' presence.

Forest access has been linked to decreased wildlife populations (Laurance et al. 2009). Researchers observed hunters with multiple *Tapirus terrestris* carcasses packed into a vehicle while traveling to the survey site, indicating that hunting, likely commercial hunting, was already present within this recently opened area. The impact of this hunting is especially concerning because the presence of threatened and disturbance sensitive species suggest that this forest is of high conservation value. Our

results also highlight our limited knowledge of mammals within the different habitats of the Guiana Shield. Due to the preliminary nature of these results, we recommend a more direct, longer-term study to build on the data collected thus far. Further research is needed to understand mammalian (micro-) habitat selection, movement patterns, and the effects that roads, forestry, and mining may have on mammal populations. This is particularly important in sites such as our study area in Berbice, where frontier roads are providing access to hunters, and facilitating habitat destruction and degradation in previously undisturbed area. Since the conclusion of this study, the logging company has ceased operations, but the road remains as an access point into the forest.

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Authors' Contributions

EADP, LI, and MAP designed the study and collected the data; EADP and MP conducted the analyses, identified the species, and wrote the initial version of the manuscript.

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Supplemental Data

R code for the analysis and graphs; dataset used in the analysis in CSV format.